ADE CORPORATION

LINEARIZER V
FIELD CALIBRATION PROCEDURE

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LINEARIZER V
FIELD CALIBRATION PROCEDURE

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1.0 The purpose of this procedure is to detail the calibration procedure for ADE Microsense linearizer circuit used in the Microsense Non-Contact Gages. Field calibration of the linearizer will be necessary whenever a Microsense probe is damaged and is replaced, or when the linearizer is replaced. The calibration may also be checked from time to time as part of a regular calibration cycle when precise measurement data is necessary. This procedure outlines the method of calibration and equipment necessary, and outlines the theory of the linearizer in a Microsense Gage.

1.1 Purpose of Calibration

The purpose of the calibration is to linearize the displacement versus output voltage function of the gage over the desired measurement range. The intrinsic sensitivity vs displacement function is shown in Figure 1; the probe current, I_p is proportional to capacitance divided by distance, (ideally a hyperbola). The ideal linearized displacement vs output voltage curve, Figure 1 E_o, could be obtained if the output voltage could be made to follow curve E of Figure 2. This can be approached quite closely by adjusting the gain of the amplifiers processing the signal I_p so that individual segments of the I_p curve are made to be nearly coincident with the ideal E_o curve (straight line). Obviously the larger the number of segments used, the smaller the deviation from the ideal straight line (see Figure 2). This is accomplished by means of a 'Break Point Linearizer Circuit'. The Break Points for each seperate segment are positioned by a potentiometer. The resultant curve, E_o actual, of

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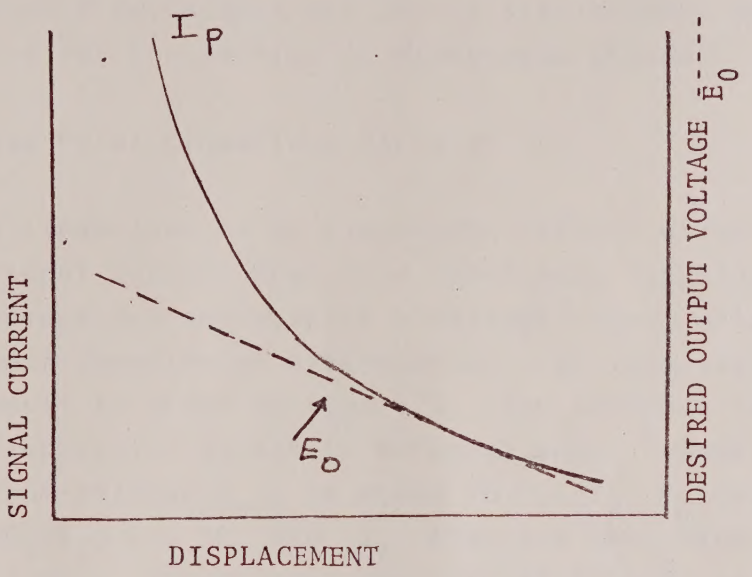

FIGURE 1

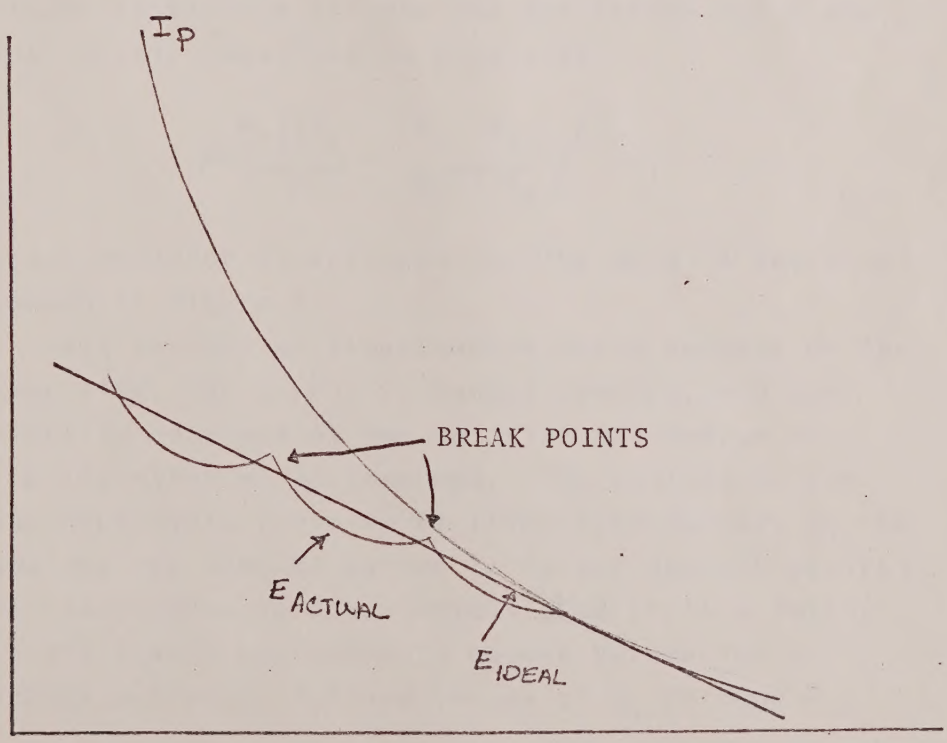

FIGURE 2

Figure 2 represents the actual displacement vs voltage curve for the particular Microsense Channel.

1.2 Break Point Linearizer Circuit

The linearizer is an electronic circuit which accepts an input current that is a non-linear function of displacement and outputs a voltage signal which is a linear function of displacement. An idealized linearizer circuit is shown in Figure 3. The switches (actually a semiconductor switching network) shown close when the output voltage E_{out} is equal to E_1, E_2, E_n (where $E_n > E_2 > E_1 > 0$). E_1 and E_2, etc. are the break point voltages. The gain of the circuit between an output voltage of 0 and E_1 is simply $G=\frac{Rf}{RI}$; between $E_{out}=E_2$, R_1 is in parallel with R_f, thereby decreasing the total feedback resistance between the amplifiers input and output points resulting in a gain of

$$G=\frac{R_f \,||\, R_1}{R_I} = \frac{R_f \quad R_1}{R_f + R_1} \Big/ \; R_1$$

As each resistor is switched in, the gain is decreased as shown in Figure 4.

The input current vs displacement curve depends on the sensor size, the sensor to target spacing, and the dielectric constant of the material and medium in which the material is immersed. The section of the ideal hyperbolic curve to be linearized depends on the range and the nominal sensor to target spacing desired. Once these parameters are established it is a fairly straightforward procedure to choose values for a feedback resistor (R_f) and values of R_1 through R_n.

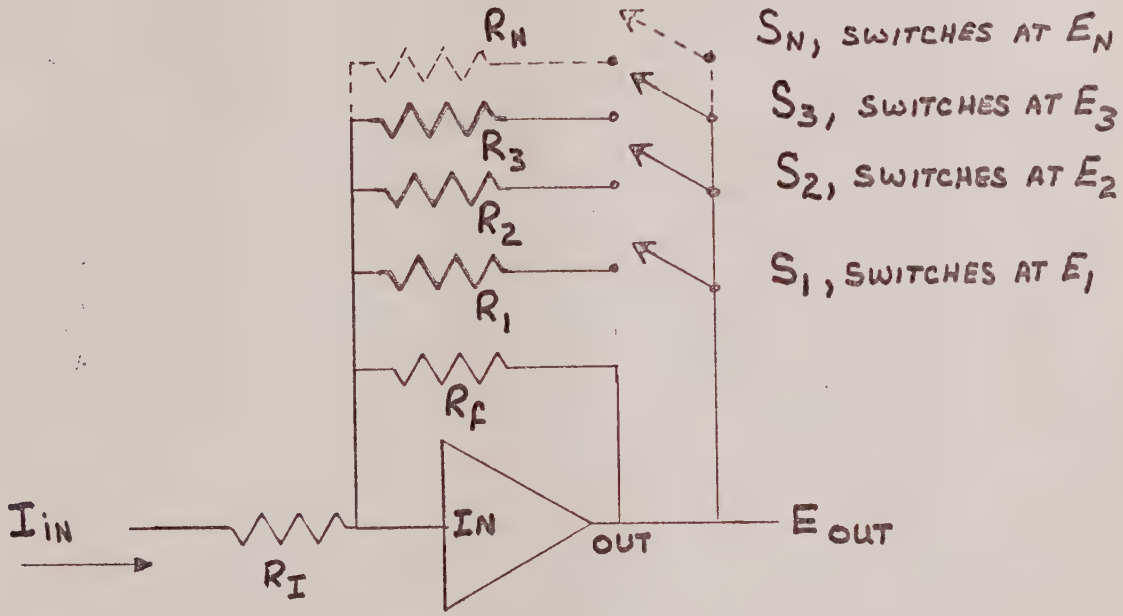
R_N
R_3
R_2
R_1
R_f
I_{IN}
R_I
IN
OUT
E_{OUT}
S_N, SWITCHES AT E_N
S_3, SWITCHES AT E_3
S_2, SWITCHES AT E_2
S_1, SWITCHES AT E_1

FIGURE 3

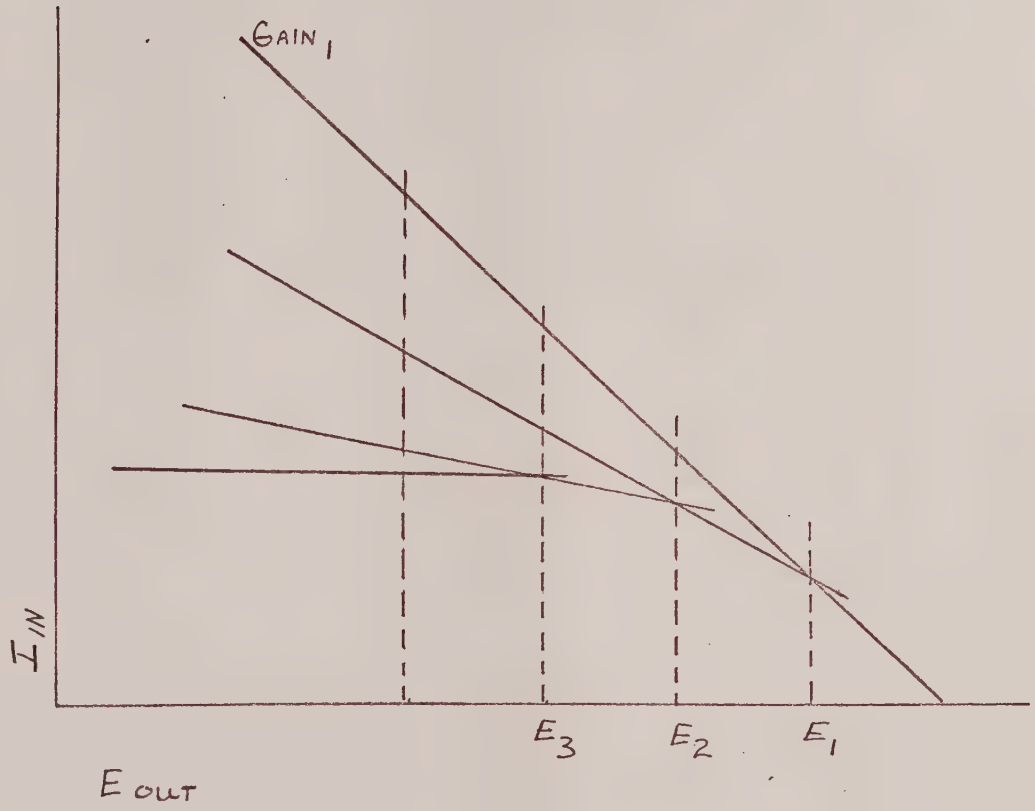

FIGURE 4

2.0 Calibration Procedure

Linearizers are calibrated to give an output voltage E_o, of zero volts to -10.000 volts for a probe displacement of maximum to minimum respectively for the measurement range.

2.1 Equipment Required

2.1.1 Calibrator with movable reference surface and sufficient range and resolution for desired calibration.

2.1.2 Digital voltmeter with accuracy of 1 mv in 15 V.

2.1.3 Resistor decade box 50K ohm to 2 meg ohm in 1 ohm steps, 1% tolerance.

2.1.4 Extender card for linearizer.

2.2 Linearizer V Calibration

The linearizer cards are identified by a small label attached to each one. When calibrating a linearizer be sure of its type.

2.2.1 Before the calibration procedure begins, some simple checks for proper operation of the unit should be made;

(a) Remove Microsense Gage from case.

(b) Place Linearizer on extender card to provide access to test points.

(c) Turn console "ON" and allow ½ hour for warm-up.

(d) Check for +15.000 Volts ±.030 Volts at Pin U with DVM.

(e) Check for -15.000 Volts ±.030 Volts at Pin R with DVM.

(f) Adjust the rear panel sensitivity potentiometer for a reading of 0.000 Volts at Pin K of linearizer.

(g) If all of the above parameters check out procede with calibration.

2.2.2 Refer to Figure 5 for component and Pin location on Linearizer

(a) Remove the offset resistor on the Linearizer card.

(b) Fixture the probe in the calibrator, and back the calibrator off to the nominal maximum spacing.

(c) Observe the polarity of the voltage at Pin V with the DVM. The amount of voltage present at Pin V is unimportant at this time; the polarity is important. If the polarity at Pin V is (+) positive, connect the decade box to Pins AA and Pin U. If the polarity is (-) negative, connect the decade box to Pins AA and Pin R.

NOTE: The decade box setting before connection should be greater than 1 meg-ohm.

(d) Adjust the decade box value for a DVM reading of 0.000 volts at Pin V.

(e) Adjust the calibrator in, until the DVM reading is -10.000 Volts at Pin V.

(f) Back the calibrator out the full calibrated range of the gage. This is the new maximum spacing point.

(g) Readjust the decade box value for a 0.000 Volt reading on the DVM at Pin V. This is the 'new' mechanical zero point.

(h) Adjust the calibrator for a reading of -10.000 Volts at Pin V. This calibrator setting is the 'new' near standoff point.

(i) Back the calibrator out the full calibrated range of the gage from the 'new' near standoff point. Readjust the decade box value for a reading of -.000 Volts at Pin V.

(j) Repeat steps (g), (h), and (i) until the change of the calibrator settings for the full calibrated range of the gage yields a voltage swing of 0.000 to -10.000 Volts at Pin V, ±0.030 Volts.

(k) Set the calibrator to the center of the full calibrated range. If the output voltage at Pin V is -5.000 ±0.030 Volts, proceed to Step R. If the value at Pin V is off by more than ±0.030 Volts, record the error, including polarity, and proceed to Step L.

PIN V	PIN XY
-1VDC	-10 VDC
-5	-0
-9	+10VDC

(l) Move nominal far spacing point toward surface by 5% of full calibrated range (i.e. 5% of maximum spacing minus minimum spacing).

(m) Set decade box so that Pin V output is 0.000 Volts.

(n) Move probe in by full calibrated range.

(o) Set gain control to yield output voltage of 10.000 Volts.

(p) Check again inccenter of calibrated range. If error has decreased (for example, by 50%) move in another 5% of full calibrated range and repeat Steps (m), (n), (o), and (p).

(q) Repeat as outlined above until near point, far point and center point are all within ±0.030 Volts of ideal value.

(r) Adjust probe to far spacing point (0.000 Volts at Pin V).

(s) Remove decade box and replace with fixed resistor.

(t) Adjust sensitivity potentiometer (rear panel) until voltage at Pin V is again 0.000 Volts.

(u) Check near and center point voltages.

(v) Return to far point, check voltage.

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FIGURE 5.

NOTES: 1. UNLESS OTHERWISE SPECIFIED
2. SCHEMATIC REFERENCE: D4-10782

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